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THE

GAS FITTER'S GUIDE,

SHOWING THE

Principles and Practice of Lighting with Coal Gas,

ALSO GIVING

DETAILS OF FITTINGS

Suitable for Lighting Dwelling Houses, Shops, Warehouses, Streets, and Public Buildings.

BY JOHN ELDRIDGE,
GAS ENGINEER.

Fourth Edition.

WITH ILLUSTRATIVE DRAWINGS.

ENTERED AT STATIONERS' HALL.

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PREFACE.

The great importance and advantage of artificial light make it one of the most interesting subjects of our study; and when we consider that our great luminary, the sun, gives us light only eight hours per day in some parts of the year, the production of a good artificial light may be compared with the value of prolonging the pleasures of life one-third, which otherwise would be lost in total darkness.

Also, it not only enhances our daily comforts, in obtaining our daily bread, but regenerates mankind from barbarism and brutality to the perfection of an enlightened understanding.

With view of preventing the calamitous accidents caused by the ignorance and carelessness of persons in charge of gas lights, I trust that my endeavour to simplify and elucidate its principles will not only be acceptable to the practical workman, but to all persons who find pleasure in obtaining useful information.

THE AUTHOR.

PREFACE TO THE FOURTH EDITION.

In consequence of the Third Edition having been received with great favour, I have much pleasure in issuing a Fourth Edition. In connection with gas manufacture we ought to protect those who work in coal mines from those awful explosions; and I venture to suggest that the mines could be lighted with gas with a properly constructed lamp.

The immense loss of life demands the attention of the Legislature.

THE GAS FITTER'S GUIDE.

PIT coal, the foundation of our gas lights, was first brought into London in 1357; and it is very surprising that the flame of our common domestic fires, which is really coal gas unpurified, should have remained dormant 450 years before its simple distillation, in a retort, was verified in the production of illuminating gas. We have a great many classes of coals; some sorts are more suitable for the furnace than for gas-making. The peculiarities of coals have been very accurately explained by several writers. For many years coal was considered a mineral, but the moderns have classed it with vegetables. The latter is a very far-fetched theory, and it is not worth the time spent to prove whether it is so or not. But the mind becomes interested in inspecting the neatly formed mouth of a coal pit, paved with stones, with an opening about seven feet square, having the appearance of a very deep well, with two flat wire ropes about six inches wide, and one inch thick, alternately winding up coals in an iron cradle, and letting down an empty cradle. The pulley that guides and winds up the flat rope is similar to the action of a common measuring tape, and as large as a cart wheel, to prevent crippling the rope. Coals are drawn up a shaft 700 yards deep in about two minutes, by a steam engine, with only three men at the pit's mouth to take off the full cradles, and replace the empty ones.

The comparative value of coal with other species of fuel has been determined by finding how much of each is required to melt a given quantity of ice in a given time: thus, one pound of good coal will melt ninety-one pounds of ice; coke, ninety-three pounds; culm, forty-six pounds; charcoal, ninety-five pounds; wood, ninety-one pounds; peat, nineteen pounds; hydrogen gas, 370 pounds.

The first process in making coal or carburetted hydrogen gas for illuminating our dwellings, is to distil the coal in a cast iron or clay retort, see plate fig. 1. Many experiments have been made to discover the best shape and size for retorts. They may be compared to our steam-engine boilers for generating steam, and the economy of gas lighting chiefly depends upon the skilful working of the retorts. They have been made in wrought and cast iron, moulded clay, and built up fire-bricks of various shapes, as elliptical, cylindrical, ⌓ shaped, &c., but those in general use are the ⌓ shaped, of cast iron 1 inch thick, 18 inches wide at the bottom, and 12 inches high or rise to arch, and 7 feet long, weighing about 25 cwts., in country gas works; but the London works have them about 16 feet long, with a mouthpiece at each end, and are called double retorts. The iron retorts are made with a flange at the open end, in order to fix with bolts and nuts, a short tube called a neck or mouthpiece. The retorts are charged with coal with a long iron scoop shovel, about half full. It will be observed that the retort is fixed in a horizontal position, with the flat bottom next to the fire. Flues are constructed all round of fire bricks, similar to an oven. Only one retort is shown in the drawing, but in practice, five, seven, or more are fixed together, called a bench, one above the other, and fire from the furnace is made to circulate equally on all of them.

A very brisk fire is made in the furnace, which soon makes the whole of the retorts red hot, also the charge of coal inside the retort. The process of distillation is allowed to go on for about six hours, and during this time all the gas is generated that can be economically obtained. This charge is now drawn out with an iron rake into a brick vault below, or put into the furnace; that which is not used is quenched with water, which is our coke of commerce.

The coals in the retort expand very much, one ton of coals after distilliation produces about 14 cwt. of coke: a bushel of coke weighs about 45 pounds, and a bushel of coal 84 pounds; it requires about 5 cwt. of coke in the furnace to generate or carbonize one ton of coals in the retort. 84 pounds of good coal will make 430 feet of carburetted hydrogen gas of the specific gravity ·500, and as a cubic foot of atmospheric air weighs 1·2 ounces at 60 degrees Fahrenheit when the barometer stands at 30 inches, a cubic foot of coal gas will weigh about half an ounce. Coal gas has been made at ·400 specific gravity, but the lighter gases are not so luminous; for oil gas at ·750 gives double the light of coal gas at ·450: therefore, we must calculate the power of light in direct proportion to its gravity; and although a fluid, its solid particles can readily be detected; thus the principle of the Davy lamp with wove wire gauze, about sixty meshes to the inch to prevent explosions, is this:—flame is a gaseous matter heated to intensity so as to become luminous, and the degree of heat is greater than solid bodies heated red-hot; for a spark or a red-hot poker will not produce flame from a gas-burner; but you must have a flame to set it on light. Now as metals are rapid conductors of heat, when the flame comes in contact with the wire gauze, its temperature is so reduced by the conducting power of the metal that although the gas passes freely through the meshes, and is still very hot, it is not sufficiently so, to become luminous. That wire gauze does completely intercept the flame of a burning body may be proved by holding an iron ring round the wick of a candle; the flame will be extinguished, owing to the wire conducting away the heat with such rapidity, that the gaseous matter is cooled below the temperature necessary for flame. By placing in the central part of the flame a piece of wire gauze, it becomes coated with charcoal, which is the solid matter disengaged from carburetted hydrogen gas, the cause of its illumination when properly burned.

It will be observed that the neck of the retort extends beyond the brick-work of furnace (see fig. 1), therefore, does not become red-hot like the body of the retort. From this neck a pipe rises and ultimately turns over into a large horizontal pipe (fig. 2) called the hydraulic main, and prevents the gas from going back into the retort when drawing the charge. This pipe has a partition like the stop-end of a half-round eaves gutter, which keeps the tube half-full of water, and tar. The gaseous vapours are condensed from the ascending pipe of the retort.

A pipe (fig. 3) is fixed in the hydraulic main above the partition which carries the tar to the tar-well (fig. 4). Another pipe A fixed to the top of the hydraulic main which carries the impure gas to the condenser (B), one end of the syphon pipe dips into a trough of water, which is connected with the tar-well. The gas rises through the water and passes to the scrubber (C), consisting of pieces of broken earthenware, which also collects tar from the gas.

The component parts of gas, before it has been purified, consist chiefly of carburetted hydrogen, pure hydrogen, carbonic acid, carbonic oxide, sulphuretted hydrogen, ammonia, &c. The only substance calculated to give light, after the gas has been purified, is carburetted hydrogen. The gas is conducted into the bottom of the purifier, (fig. 5), which has three divisions filled with lime water of the consistence of cream : oxide of iron, and dry lime on wire-work, have been used with more or less success as purifiers. The machine is worked by cog-wheels and a windlass, and, by the agitations of the diaphragms, the gas is made to pass from the bottom to the top, whence it is carried by a pipe to an immense gas meter (fig. 6), purified, fit for use. The use of this meter is to keep a check on the stokers and retort men during the night, which will at once detect any irregularity of their duties. The action and principle of the meter will be given with the details of gas fittings.

From this meter, the gas is carried by a pipe under ground, and rises through the tank of the gasometer. (fig. 7). The tank is sometimes built of brickwork, but now chiefly of cast iron plates with flanges, and screwed together with bolts and nuts, packed with hemp and sometimes with wood, united with white and red lead cement, similar to a brewer's vat ; it is filled with water, and forms a water joint with the gas-holder, so that no gas can escape. The gas-holder, is balanced by weights and chains similar to a sash-window, which rises when the gas passes in through an upright pipe above the water line, the direction of the arrows show the inlet and outlet pipes. When gas is withdrawn for use, the gas-holder sinks in exact proportion, so that the atmospheric air is entirely excluded. It is made cylindrical, because this shape holds the most gas : also it is stronger, more easily made, and consumes less iron than a square or angular shaped vessel. The thickness of iron used for the sides is No. 16 wire gauge, and the top, No. 12, rivetted together. Strong brown paper is put between the laps to prevent the escape of gas ; the rivets should be about ¾ inch apart from centre to centre. It is of the utmost consequence that the gas-holder should be well made, for should it leak when in use, it will not only cost a considerable sum in finding out and stopping the leaky parts, but be a great waste of gas, and expense to the gas company.

When a gasometer is filled for the first time, it must be immersed in water till all the air escapes by a top or main valve ; otherwise by mixing the atmospheric air nine parts, and the coal gas one part, an explosive mixture is produced, equal in power to the explosion of gunpowder. Of course it requires flame, such as the light of a candle, to make an explosion ; it will not explode spontaneously. 15,000 cubic feet of the mixture, as stated, would be equal to the explosion of four barrels, or 400 pounds of gunpowder. A barrel of gunpowder contains 1½ cubic feet. It is almost impossible that a gasometer should contain an explosive mixture or meet with such an accident, which experience has shown since the first lighting of gas in Pall-mall, in 1802. This gas mixture is used as a motive power in a cylinder to supersede the steam-engine. The mixture is produced by the accurate action of slide valves, and is then exploded by an electric spark from a galvanic battery, or by a gas-burner. The saving is stated to be considerable, which may be for small engines under 14 horse power ; but I should say for larger engines it has no chance of competing with coal or coke steam-engines.

The usual pressure of the gas in the street mains is a column of water two inches high, so that it will not only over-balance the friction of gas in the main pipes and put the gas meter in action, but will make it descend below the level of the gasometer to any ordinary depth. Should the gas be required to descend one hundred feet below the level of the gasometer, then it would require the pressure of four inches of water. There is a small pressure gauge sold by manufacturers of gas fittings that can easily be screwed to any pipe in order to measure its pressure. The pressure is graduated on a glass tube similar to a barometer. The gas from cannel coal is much finer than that made from the ordinary coal. The No. 1 fish-tail burner for this gas is in proportion to No. 3 burner for the common coal gas, therefore the cannel coal gas requires less pressure to obtain the same light. As the gas entering the gasholder is warmer than the outward temperature, it prevents the water in the tank from freezing, which is an advantageous circumstance.

The gas flows out of the upright tube C into the street mains. These cast iron mains vary from 2 to 48 inches in diameter, and are generally proved by a pressure of a column of water 256 feet high ; and as 32 feet are equal to a pressure of 15lbs. on the square inch, this trial is equal to a pressure of 120lbs. per square inch. No such pressure is wanted in gas works : the object is to have sound pipes, to prevent leakage by a sand hole or flaw, not observed in laying down the pipes. Notwithstanding all this care, it is calculated that 10 per cent. of the whole gas made is lost in the mains by leakage. Possibly we may discover that glazed clay pipes may be more economical, and entirely supersede the cast iron pipes for street mains, connected together with plaster of Paris and Portland cement.

Cast iron main pipes from 4 to 10 inches diameter are ⅜ inch thick ; 10 to 20 inches diameter are ½ inch thick ; and 20 to 30 inches diameter are ⅝ inch thick. Wrought iron tube 1 inch diameter is ⅛ inch thick ; and any size from 2 inches is ¼ thick, and will bear a pressure of 130 pounds per square inch. The strength of pipes is inversely as the squares of their diameters ;

the smaller the pipe, of course the less internal surface it has, or bursting pressure: therefore small pipes of the same thickness are stronger than large ones, which will appear a paradox till we examine the question practically.

A very easy way of calculating the contents of pipes which I believe has never before been published, is shown by the following rule. Suppose you have a pipe of 3 inches diameter, and 300 yards long.

Rule.—Square the diameter in inches, multiply this product by the yards in length, and divide by 10. The quotient gives imperial gallons, which again, divided by 6, will give cubic feet. After one trial, it can be done mentally.

Example.—$3^2 \times 300 \div 10 = 270$ gallons.

With respect to the size of gas mains, we must take into consideration the number of outlets, the length, and number of burners likely to be wanted. It is a difficult problem : the velocity of gas will be directly proportionate to the pressure, independent of its specific gravity. The resistance to motion in pipes is in proportion to the squares of the velocity ; the expenditure of gas by a pipe of uniform size is in direct ratio of the pressure indicated ; and in the inverse ratio of the square root of the length of the conduit pipe. A 10 inch main pipe 200 yards long would discharge about 18,000 cubic feet of gas in five minutes. And as pipes are in proportion to the squares of their diameters, the proportion of a 5 inch compared to a 10 inch pipe is $5 \times 5 = 25$ to $10 \times 10 = 100$; therefore, as 25 is to 100; that is, a 5 inch pipe will only contain a fourth part of a 10 inch pipe.

In laying down main pipes, there should be a gradual rise or fall, sufficient for the spirit level to flow freely up, to allow the liquid which condenses in the main to drain into a trap called a syphon, as shown Figure 9. In long lengths of main pipes, the pipes fall each way, similarly to the eaves gutters for rain water to the cistern-head. There is a screw-plug in the cover, to allow the vessel to be pumped out occasionally.

Very little water collects, except there should be any damage in the pipes, which allows the rain water to filter.

The joints consist of a spigot and faucet, known in the trade as socket pipes: the depth of socket averages four inches. Spun yarn is first well caulked in with a blunt chisel, and the last inch is filled up with molten lead from an iron ladle, and then well caulked. In making the joint, to prevent the lead running from the socket, a roll of moist clay is coiled round the socket; but the improved plan is a band of iron with three joints, which saves ten per cent. in time and labour. The cost of making a 4 inch socket joint, opening ground, and filling in, is 3s. 6d. for a 9 feet pipe.

Sluice valves are fixed in the mains to prevent waste of gas; also a regulator (see figure 8). The regulator is made similarly to the gas-holder, with the exception of its having a conical valve at the bottom, which regulates the flow of gas. When any extra pressure of gas occurs, the cap rises, and draws the valve into the inlet opening: thereby only a proportionate quantity is delivered, according to the weight fixed on the cap. We shall explain at length when we come to gas fittings.

It will be observed that the gas mains are buried in the earth from 15 inches to 5 feet deep,—not to keep them from freezing, but from being damaged by cart wheels, and for convenience. Branches are carried from the mains to our shops and dwellings.

It would be a great boon to the public if our water companies made a bye-law for all their branch pipes to be buried 18 inches in the earth till they reached inside our dwellings. We should not then become frozen out, or fear Jack Frost cutting off our water for twenty days at a time, which happens now every year, to the disgrace of the age, and the directors of water works.

Street lamp posts are made of cast iron, and are hollow. See Figure 10, showing a ½ inch iron gas tube from the main, and passing up the centre of the lamp pillar, till it reaches the gas lamp. A socket and burner is then screwed on: the fish-tail is now chiefly used; it consists of a cast iron tube ¾ inch long, with two holes about $\frac{1}{25}$ inch, drilled at an angle at the top, which meet in the centre, and form two outlets like the letter V. The other burner is called a bat's-wing, which consists of a slit cut on the top, similar to a fish's mouth when shut: it therefore makes a flat sheet of flame (see Figure 20.) These cast iron policemen have almost superseded our invisible blues. Dick Turpins on our highways, and Jack Sheppards in our towns, all shun the glare of carburetted hydrogen; and as prevention is better than cure, these street lamps have proved to be the most vigilant and long-sighted policeman.

The old adage says, "Give a dog an ill name, and then hang him without judge or jury;" and it is on a par with the private slander of the present day. And I must say, many persons find fault with the night duties of the police from the greatest ignorance. I once happened to arrive, per rail, in a large country town, late in the evening, and could not obtain a bed on account of the overflow of "roughs" to the horse-racing that day. I was compelled to walk the street all night, in cold, bitter weather. During my perambulation, I only met two policemen, and, owing to the darkness, I could not find the police station; but the number of low people and their vile language, whose object was betting and swindling, was disgusting, being the offspring of horse-racing. If ladies and gentlemen did but know the amount of vice and ruin—the attributes of the race-course, they would do all they could to abolish it. And from this experience, as regards the police, the night duties are three times too long: they ought to be relieved every three hours,—then we should not find them off their beat; also should be armed with revolvers.

We will now consider internal gas-fittings. For general illuminations I consider them a great waste; therefore a national sin; and so long as there are people who are frozen for want of coal and fire, I will never recommend throwing bread to the dogs. The gas-fittings at our theatres are badly conducted, and they are the worst fitted up places in the metropolis. The escape of gas is a great nuisance; also the large gasalier in the centre is a cumbrous piece of mechanism, and, from the immense heat forming a focus at the ceiling, requires more ventilation pipes than are now used. The foot-lights are a bad arrangement. If the foot-lights and orchestra were intrenched below the stage floor, reflectors at an angle would throw up the light, and the audience would have a fair open view, as well as the improvement in the scenery. There requires more ventilation in all public buildings, which should be in the ceilings. If they are fixed in the side walls, it should be carried by a pipe into a chimney or roof. All window ventilation is bad, as a current of cold air is directed on the heads of those below, which is the quickest possible way of catching cold. See fig. 22 and 26.

Every person consumes two cubic feet of air per minute, and three gas burners consume one cubic foot of air per minute; that is, it consumes its oxygen, which is 1-5th part, and the remainder, 4-5ths of nitrogen, which is incapable of supporting life or flame, should be allowed to flow out, and fresh air to flow in at the bottom, through gauze wire, to prevent draughts. When you see the vapour condensed on the walls and windows you may be sure there is an imperfect ventilation. We estimate for lighting and warming our buildings, but the most important part, viz., ventilation, is seldom thought of. Should the contractor show the necessity of it, and give a price, the chances are, he loses the contract altogether. Burning gas without a ventilator or pipe to carry off the effluvia, is as barbarous as making a fire in a room without a chimney to carry off the smoke. If a pipe of 2 inches diameter were fixed between the joists, with a funnel elbow over the gasalier, and the other end carried into the chimney, it would be a general ventilator: of course, an open ornamental rosette covers the mouth of the tube, or an Arnott valve ventilator over the mantelpiece would answer the same purpose. See fig. 23.

When the gas is required to be laid on from the main to the dwelling-house, notice must be sent to the company. All gas meters are stamped and proved by a district board, according to the Act of Parliament; also you must get leave to take up the pavement for laying the branch pipe to house. The following size pipes are requisite for the number of lights required.

For 200	lights	2	inch iron tube.
120	„	$1\frac{1}{2}$	„
70	„	$1\frac{1}{4}$	„
50	„	1	„
25	„	$\frac{3}{4}$	„
12	„	$\frac{1}{2}$	„
6	„	$\frac{3}{5}$	„
2	„	$\frac{1}{4}$	„

The sizes $\frac{1}{4}$ in., $\frac{3}{8}$ in., and $\frac{1}{2}$ in. diameter are generally used as branch pipes to the burners. Please observe that all pipes are measured by the internal diameter, except the small brass and copper tubes, which are measured outside diameter.

Pipes used in gas-works, are made of cast and wrought iron, lead, block tin, vulcanised india-rubber, and composition pipe, made of lead, tin, and antimony.

As gas flows with greater velocity in the upper floors of buildings, therefore the rising main may diminish upwards. Thus, if the size be $1\frac{1}{4}$ inch at the basement, it may be reduced to $\frac{3}{4}$ inch pipe at the third floor. The specific gravity of coal gas being about half the weight of atmospheric air, we may consider its motion on the principle of an inverted syphon, therefore will follow the law of falling bodies. Suppose you have two weights suspended over a pulley wheel, in the proportion of one to two pounds : now the two pound weight will overbalance the one pound, and, (by omitting the resistance of the atmosphere and friction,) will fall 16 feet the first second, three times or 48 feet at the end of two seconds, and five times or 80 feet at the end of three seconds, and so on ; this agrees with the same law, that the spaces of falling bodies are as the squares of the time in falling per second, viz., the first second it falls 16 feet, in two seconds squared $2^2 \times 16 = 64$ feet, in three seconds $3^2 \times 16 = 144$ feet, therefore the alternate intermediate spaces $16+48+80$ feet make the sum of 144 feet in three seconds. In practice we must consider the various stoppages and bends in pipes ; by barely giving the size large enough, in pipes or anything else, is false economy; yet without a rule there may be a great and useless expense by over-doing it; therefore a margin of 25 per cent. is advisable.

To well proportion the light to large rooms is of great importance; and as far as windows and the solar light are concerned, a good general rule will be,—for churches and chapels, to take the area of the external walls, and one-third of this measurement will give the area for window light. For dwelling-rooms, take half the area of the external wall containing the window for the glass surface will make a comfortable light. There is an evil in having too much glass, as it cools the room too fast in the winter season. One square foot of window glass will cool 1½ cubic feet of warm air in the room to the external temperature per second; that is, if the room be warmed to 60 degrees Fah., and the thermometer stands at 30 deg. Fah. outside, there will be a loss of 90 cubic feet of warm air at 60 deg. per second from a window containing a surface of glass of 60 square feet.

The number of gas burners requisite for lighting a church or other large building may be computed thus. Take the area of the floor and divide this by 40, will give the number of fish-tail burners to be distributed according to circumstances. Example: a church 120 feet long by 60 feet wide, contains 7,200 feet area; divided by 40, gives 180 burners required for the same.

The gas company generally supplies the gas meter, shown in position (fig. 11,) with main cock (fig. 14.) Lead pipe is used for the inlet and outlet to the meter, being more easily bent to the position than iron pipe. A cap and lining is soldered to the lead pipe, and the male screw of the main cock is screwed into the iron tube from the street main.

There are two kinds of gas meters in use; viz., the wet and the dry. The wet meter has the external appearance of a mantelpiece clock, which is half-filled with water, whence its name. It has a floating valve over the inlet pipe; and should the water be drawn off or be evaporated in the natural way, which prevents the accurate measurement of the gas, the valve falls and closes the inlet aperture, therefore no gas can be used; by filling the meter with water to the proper level till it runs out of a side aperture (which is kept closed by a screw cap when in use,) it is regulated again for use. There is a drum inside the cylinder, with three divisions or compartments, similar to the buckets of a water wheel; but instead of filling the buckets with water, they are filled with gas by a pipe passing through the centre, and rising above the water line; the pressure of gas makes the wheel revolve, and supposing each compartment to contain 576 cubic inches, one revolution will register one cubic foot of gas passed through the meter.

On the spindle or shaft of the drum, is fixed a pinion-wheel, which is geared to a larger wheel in the proportion of 1 to 10, so that ten revolutions of the meter make one revolution of the large cog-wheel, which carries an index-hand like a clock. The dial is divided into 10 parts, and is marked cents; therefore when the whole 10 divisions are passed through, similarly to the hour-hand of a clock, it registers 1,000 cubic feet. There are other pairs of wheels to the train which register thousands, &c. Suppose the dial marked cents has made one revolution, the train of wheel-work moves the hand marked thousands one division, then the cents dial-hand makes another revolution, which moves the thousand-hand to two thousand; and so on of all the other wheels.

The practical way of taking the state of the meter is to get a card; suppose the cent dial-hand is between the 3 and 4, or just over the 3, write down 300; suppose in the next left hand dial marked thousands, the hand is between 5 and 6, write 5 to left of 300, making 5,300; the next dial stands between 2 and 3, write 2 to left of 5,300, making 25,300; the next dial-hand is between 1 and 2—write down 1 to left of 25,300, making 125,300, which will be the state of the meter. On the next examination, which is usually every three months, write down the figures as directed, which, supposing they should stand at 143,800, by deducting the former, will give a difference of 18,500 cubic feet, which is the quantity of gas consumed during the interval of three months.

The wet meter was the first invention, and will measure very accurately; the only drawbacks are the occasional supply of water and the freezing in winter, if not well clothed with matting or hay.

The dry meter acts like a pair of bellows or an accordion, and therefore requires no water; but instead of the hand lifting or expanding the bellows, it is the pressure of the gas which extends the meter. It has a slide valve, like the cylinder of the steam-engine, which admits and expels the gas in quantities, similarly to the wet meter. The corrosive nature of gas caused great difficulty in perfecting this meter, which is now preferred.

When the meter is once fixed and in use, no workman is allowed to touch it but those employed by the gas company. It may be fixed outside the house under cover, or in the most convenient situation inside, which is generally done for the convenience of turning off the gas.

Near the meter (fig. 12) is shown a mercurial regulator. The small size for fifteen lights, is an oblong iron box 8 × 4 × 3 inches. It is made with a convex valve, acting on the same principles as the larger one (fig. 8) at the works, but instead of a water joint it has a mercurial joint, as mercury does not evaporate, and requires only $\frac{1}{13}$th of the space of water. It is much better adapted for dwellings and shops, with the advantage of requiring no attention to keep it in repair.

The object of the regulator is to enable any consumer to reduce the pressure of the gas, which varies from ¾ to 3 inch pressure, as delivered to him from the mains, to the most economical burning point, which is found to be about ½ inch column of water.

It often happens that at night, when nearly all the lights are turned off, those remaining will rise 3 or 4 inches higher, which therefore become dangerous, and may probably set the house on fire; but with the regulator this cannot happen, as the last light will always be regulated to the same height as at the commencement of burning: also there is a saving of gas, and the atmosphere is kept more wholesome by perfect combustion.

The usual size fish-tail burners are No. 3; the average gas passed through will be as follows; for ½ inch pressure, 2¼ cubic feet; for 1 inch pressure, 4 feet; for

1¼ inch pressure, 5 feet; for 2 inch pressure, 6 feet of gas per hour.

There are a great variety of gas regulators made, to screw on the socket of gas burners, consisting of a small cylinder the size of a pill box, which is filled with wadding or small leaden shots, in order to retard the gas passing through the burner, and is therefore supposed to regulate the flow of gas; they are something like a chip in porridge—do neither good nor harm. Although we have a great number of worthless patented inventions, yet the few valuable ones will compensate the public for any disappointment they may occasion, and it is truly astonishing that our legislature should be so ignorant or perhaps careless, in not putting the inventors, the genius and sinew of England, in a proper position by rewarding them, rather than to charge and tax them for their patent rights. If any man discovered a rich gold mine in England, would not the country be enriched? Have not our steam-engines enabled the people to pay the taxes and keep up the revenue? for without them hand labour could not compete with other nations. At all events, if we can get our books protected by being entered at Stationers' Hall for 5s., surely we ought to get our inventions protected for the same sum. We have plenty of people who can write books, but inventors are men of a higher order; and instead of our having to say that inventors never get rich, we ought to honour and reward them as conquering heroes.

Fig. 13 shows a modern improvement in gas lighting called a sun-light, which is fixed a few inches from the ceiling, with an internal tube of about 6 inches diameter to carry off the direct heat from the burners, and an outside funnel reaching to a chimney; or, what is better, passing through the roofing, and covered with a cap or windguard. This pipe should be twice the size of the inner tube. The burners are made in clusters of nine, and they are from 9 to 126 lights. The funnel mouth next the burners is sometimes made with talc squares, glazed like a window. The tubes have the great advantage of ventilating the room and radiating the lights in a superior manner. A ground glass screen below the lights, to soften the glare in some situations, as in the case of low ceilings, may supersede the gasalier. Great care should be taken that all wood work should be 10 inches from the pipes, to prevent it catching fire. Fig. 15 shows a stop-cock in order to turn off the sun-light only, called a bye-pass, to a small light.

Fig. 16 is called a syphon, and as all gas-tubes should be fixed with a small rise, this syphon collects the condensed liquids, and should be drawn off occasionally by unscrewing the plug end. When the lights flicker, it shows there is water in the pipes : the syphon prevents this.

Fig. 17 shows the hydraulic gasalier (commonly called a chandelier, which signifies—for candles.) It is made with a cup-and-ball joint near the ceiling, and a sliding water-joint; on the principle of the gas-holder, a central and an external tube is fixed to the base, called the body, and a down-rod from the ceiling-plate passes between them; water is poured between the tubes, and forms a water-joint or hydraulic slide: the gas passes down the centre tube as shown by the arrow. The body and branches of the gasalier are suspended and balanced by weights and chains passing over pulleys, so that it can be drawn down about 18 inches, and raised at pleasure. This apparatus is quite safe from the escape of gas so long as the tube is kept full of water, but a warm room will in time absorb the water, which will get below the down-rod, and allow the gas to escape; and in a few hours an explosive mixture will be made in the room, and, should a lighted candle be brought in, an accident would occur. Every housekeeper should get a jug of water, and fill up the tube every three months, or contract with a gas-fitter to attend at stated periods of not more than three months, to examine the fittings, for it is only careless people who have explosions with gas. Fig. 31 is a glass neck to show water line.

In turning off the gas-lights at night, it is usual, first, to turn off all the lights, except one, and then turn off the meter main cock, and allow the one light to burn itself out, and then turn it off. The evil of this system is this,—by allowing the one light to burn itself out, you exhaust the pipes and make a vacuum, and of course the atmospheric air will rush in, not because nature abhors a vacuum, but to balance the universe. The consequence will be—in lighting the gas the next day, it will be some time before the burners will light, and you then say the foul air has got into the pipes. Now the fact is, you have acted unfairly with the pipes, you should have kept them full of gas like the water pipes from the tank to your kitchen, &c.: therefore, if you turn off all the cocks first, and then go to the meter and turn off the main, you will be much more safe ; for it often happens that this one gas light is forgotten to be turned off, after the main cock, and when the main cock is turned on the next day, your room is filled with gas, and an explosion occurs. One more observation respecting gas fittings: domestics should be told, that when the handle of the stop cock is in a line with the pipe, at 20B, the gas is on, or not turned off, but when the handle crosses the pipe at 20A, it is always turned off, so that a person once understanding this rule will observe the omission at a glance. From hurry or ignorance, people turn it off and then on again, and leave it so without thinking of the danger.

Fig. 18 represents a swing pendant; from the T piece in the gas pipe a nozzle pipe screws into the ceiling plate of joints shown as R. This pendant is made with a cork or hemp stuffing box, and telescope slide.

Fig. 19 represents a stiff harp-light with an Argand burner : it is called stiff when it has no swing or revolving joint, with a back plate only, and therefore cannot move. It is used for gas brackets and gasaliers where a joint is not required.

Fig. 20 represents a single brass or iron arm stiff bracket with a bat's-wing burner. Brackets are also made in glass, with a small tube running through the centre. The immense glass gasalier fixed in the Exhibition of 1862, several of the arms of which were richly ornamented with lustre drops, but over-weighted, broke down in the night by its own weight, causing a loss of about £100. Like most of the articles shown in the Exhibition, it was the Smiths outdoing the Browns ; the articles were made more for display than for utility, and when we consider that a bright register stove or a kitchen range required twenty times more work for the sake of display, than the same description of article as sold in our shops, also that bright work is placed where the first fire would spoil it for ever, I ask of what advantage are these Exhibitions? The evils are many. They entirely put a stop to the retail trade of London for six months, and introduce wholesale prices to retail customers; and then the medals given were useless to the public, because given by gentlemen who had never seen the articles in use to make a proper comparison of their merits.

Fig. 21 represents a very useful gas burner, much in use in cooking stoves or for boiling a kettle of water. It consists of a ring burner made of ½ inch tube with a few holes drilled in the top. It is fixed at the top of a cylinder, and a ¼ inch tube from the gas main is fixed at the bottom, so that atmospheric air can mix with the gas in the cylinder, and by this means the flame at the burner is much more intense. Sometimes a piece of coarse wove wire 24 meshes to the inch is fixed on a sheet-iron cylinder for the same purpose, and when lighted on the top it emits a feeble blue flame, but the heat is more intense than the usual brilliant flame.

The making of sound joints to gas fittings is of the utmost consequence. Every workman, when fixing iron tubes, should not trust to the sockets as usually fixed, but should take them all off and rub in the threads some best white and red lead, made thin, with a paint brush. All branches should commence with a long screw to enable the pipes to be taken down if required, for addition, &c.

A plumbers' joint for the main is made with the soldering-iron, or by blowing. The pipe is painted 3 inches at the end, with a mixture of size and lamp-black, and then scraped off all round 1½ inch up, which prevents the solder adhering beyond the joint; the other pipe is opened with a cone of boxwood, and must be well scraped, or the oxide will not allow the solder to unite; thus making a spigot and faucet, which are brought close together. Molten solder is brought in an iron ladle, and the workman holds in his left hand a pad of strong canvas, which he applies under the joint. The solder is poured over the pipes, and the pad catches a portion, which is pressed round the joint, till sufficient is laid over it. This is called a wiped joint.

Blowing a joint consists in holding in the left hand a bunch of burning rushes covered with tallow, a fine strip of solder in the right hand, and a brass blow-pipe in the mouth. The flame from the rushes is directed on the solder which runs round the joint prepared for it. The blown joints are chiefly used for small pipes, from ¼ to ½ inch in diameter.

Care should be taken to fix leather washers in all union joints. When pipes are laid under floors, the floors should be screwed down, not nailed, with a cork hole to detect by smell the escape of gas. The boards and windows must be opened five minutes before any light is brought near, (whenever there is a strong smell of gas,) to prevent an explosion.

The illuminating power of gas, oil, or tallow, is measured with a photometer. The principle is this :—If two lights of unequal power be made to shine on the surface of a smooth plaster wall, and a book or card be interposed, the two shadows produced by the crossing of the rays will differ in blackness in the same degree as the powers of the two lights : the stronger light will produce the darker shadow. To obtain the difference in power of the two lights, the stronger must be removed backwards, or the less light forwards, till both shadows are of the same tint, which the eye can tell to great exactness. The rule is, that the power of light is as the square of its distance. Suppose a candle to be 6 feet from the wall, and a gas light twelve feet, to be of equal shades; then $6^2=36$ and $12^2=144$ making the gas 4 times the light of the candle, or one gas light to be equal to the light of four candles.

The average price of gas is 2s. 9d. per thousand cubic feet; and considering the immense capital for plant of gas works, also the skilled labour employed, and at all hours, the present price for gas is very reasonable.

We trust our gas-fitters will soon be employed in fixing reflectors to all street lamps, and running gas services to safety gas lamps in all the coal mines in England.

PARTICULARS OF A PRIVATE GAS APPARATUS.

For 100 Gas Lights ...	Cast Iron, 3 ton, 7 cwt. Wrought Iron, 1 ton, 15cwt.
Measurement, in addition	61 cubic feet.
Price delivered at the London Docks, inclusive of Cases	£135
Price, not delivered, but fixed	£120
Weight of Fire Bricks, in addition ...	2 tons, 18 cwt.
Price of Fire Lamps, Bricks and Clay ...	£7 10s.

* * *

PARTICULARS OF A RETORT APPARATUS.

For Private Use or Exportation.

Weight of Coals to charge each Retort in pounds,	56 lbs.
Duration of each charge, in hours	4½ hours.
Gas produced from each charge, with ordinary coal	250 cubic ft.
Total quantity of Gas each Apparatus will produce per day	750 cubic ft.
Number of Lights the Gas will supply for four hours, each light being equal to eight candles	70 lights.
Dimension, in feet, and contents of Gas-holder 10 feet diameter, by 8 feet deep	650 cubic ft.
Price, wlth Gas-holder, not fixed, exclusive of brick or wood-work for buildings and tank	£95

WEIGHT OF

CAST IRON SOCKET PIPES.

Bore.	Thick.	Long.	Weight.		
Inches.	*Inches.*	*Feet.*	*cwt.*	*qrs.*	*lbs.*
1½	¼	6	0	1	0
1½	⅜	6	0	1	12
2	¼	6	0	1	8
2	⅜	6	0	2	0
2½	¼	6	0	1	17
2½	⅜	6	0	2	9
2½	½	6	0	3	11
3	¼	9	0	3	20
3	⅜	9	1	0	6
3	½	9	1	1	13
3	⅝	9	1	3	6
3	¾	9	2	1	2
3½	¼	9	0	3	1
3½	⅜	9	1	0	22
3½	½	9	1	2	15
3½	⅝	9	2	0	7
3½	¾	9	2	2	0
4	⅜	9	1	1	11
4	½	9	1	3	12
4	⅝	9	2	1	14
4	¾	9	2	3	22
4½	⅜	9	1	2	3
4½	½	9	2	0	4
4½	⅝	9	2	2	16
4½	¾	9	3	0	21

WEIGHT OF CAST IRON SOCKET PIPES (*continued.*)

Bore.	Thick.	Long.	Weight.		
Inches.	*Inches*	*Feet.*	*cwt.*	*qrs.*	*lbs.*
5	⅜	9	1	2	24
5	½	9	2	1	12
5	⅝	9	2	3	15
5	¾	9	3	2	0
5½	⅜	9	1	3	11
5½	½	9	2	2	0
5½	⅝	9	3	0	19
5½	¾	9	3	3	7
5½	1	9	5	0	16
6	⅜	9	2	0	2
6	½	9	2	2	21
6	⅝	9	3	1	18
6	¾	9	4	0	15
6	1	9	5	2	23
6½	⅜	9	2	0	17
6½	½	9	2	3	18
6½	⅝	9	3	2	22
6½	¾	9	4	1	20
6½	1	9	6	0	15
7	⅜	9	2	1	8
7	½	9	3	0	6
7	⅝	9	3	3	20
7	¾	9	4	3	5
7	1	9	6	2	4
7½	⅜	9	2	2	4
7½	½	9	3	1	8
7½	⅝	9	4	0	23
7½	¾	9	5	0	12
7½	1	9	7	0	4
8	½	9	3	2	5
8	⅝	9	4	1	26

WEIGHT OF CAST IRON SOCKET PIPES (*continued.*)

Bore.	Thick.	Long.	Weight.		
Inches.	*Inches.*	*Feet.*	*cwt.*	*qrs.*	*lbs.*
8	¾	9	5	1	20
8	1	9	7	1	20
8½	½	9	3	3	4
8½	⅝	9	4	2	26
8½	¾	9	5	2	23
8½	1	9	7	3	10
9	½	9	4	0	4
9	⅝	9	5	0	6
9	¾	9	6	0	3
9	1	9	8	1	0
9½	½	9	4	0	20
9½	⅝	9	5	1	2
9½	¾	9	6	1	8
9½	1	9	8	2	21
10	½	9	4	1	12
10	⅝	9	5	2	0
10	¾	9	6	2	14
10	1	9	9	0	9
10½	½	9	4	2	12
10½	⅝	9	5	3	8
10½	¾	9	7	0	6
10½	1	9	9	2	2
11	½	9	4	3	14
11	⅝	9	6	0	12
11	¾	9	7	1	8
11	1	9	9	3	20
11½	½	9	5	0	6
11½	⅝	9	6	1	12
11½	¾	9	7	2	9
11½	1	9	10	1	3
12	½	9	5	0	24

WEIGHT OF CAST IRON SOCKET PIPES. (*continued.*)

Bore.	Thick.	Long.	Weight.		
Inches.	*Inches.*	*Feet.*	*cwt.*	*qrs.*	*lbs.*
12	⅝	9	6	2	9
12	¾	9	7	3	22
12	1	9	10	3	4
13	½	9	5	2	21
13	⅝	9	7	0	14
13	¾	9	8	2	7
13	1	9	11	2	12
14	½	9	6	0	6
14	⅝	9	7	2	16
14	¾	9	9	1	5
14	1	9	12	1	15
15	½	9	6	1	22
15	⅝	9	8	0	16
15	¾	9	9	3	9
15	1	9	13	1	0
16	½	9	7	1	0
16	⅝	9	8	3	9
16	¾	9	10	1	14
16	1	9	4	0	18

NEW LIST OF PRICES FOR WROUGHT IRON TUBES AND FITTINGS.

INTERNAL DIAMETER.	⅛-in.		¼-in.		⅜-in.		½-in.		¾-in.		1-in.		1¼-in.		1½-in.		2-in.	
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
Tubes, 2 to 14 feet long, per foot ...	0	2	0	2½	0	3	0	4¼	0	6	0	8	0	11	1	2	1	9
Pieces, 12 to 23½ in. each...	0	4	0	5	0	7	0	9	1	0	1	4	1	8	2	0	3	0
Long Screws, 3 to 11½ in.	0	4	0	5	0	6	0	8	0	10	1	0	1	3	2	0	3	0
Bends...	0	5½	0	6½	0	7	0	8	0	11	1	3	1	9	2	3	4	3
Elbows	0	6	0	6½	0	7	0	8	0	10	1	2	1	9	2	3	3	6
Tees	0	6	0	6½	0	7	0	9	1	0	1	3	1	9	2	6	3	9
Crosses	0	10	1	0	1	0	1	5	1	9	2	3	3	0	3	6	5	3
Plain Sockets	0	1½	0	1½	0	2	0	3	0	3½	0	4	0	6	0	7	1	0
Diminished Sockets			0	3	0	4	0	5	0	6	0	7	0	9	0	11	1	3
Caps and Plugs	0	2	0	3	0	3	0	4	0	5	0	6	0	8	0	10	1	3
Back Nuts and Nipples	0	1	0	2	0	2	0	3	0	3½	0	4	0	6	0	8	1	0
Round Elbows	0	7	0	7	0	8	0	9	1	0	1	4	1	11	2	6	3	10
Iron Main Cocks	2	3	2	3	2	9	3	6	4	6	6	6	8	6	11	0	18	0
Wrought Cock Spanners			1	0	1	0	1	4	1	8	2	0	2	4	3	0	4	0
Gas Tongs	1	8	1	8	1	8	2	0	2	3	2	9	3	2	4	0	4	9

Stocks, Dies, and Taps, 2, 1½, and 1¼ in. tube, per set	£4	10	0	nett.
Do. 1, ¾, and ½ in. do.	2	15	0	„
Do. ⅛, ¼, and ⅜ in. do.	1	12	6	„

PATENT DRY OR WET GAS METERS.

		£	s.	d.
1 Light	each	1	9	0
2 „	„	1	15	0
3 „	„	2	2	0
5 „	„	2	10	0
10 „	„	3	5	0
20 „	„	4	8	0
30 „	„	5	15	0
50 „	„	8	10	0
60 „	„	11	10	0
80 „	„	14	10	0
100 „	„	18	10	0
150 „	„	26	15	0
200 „	„	32	5	0

BRASS MAIN GAS COCKS.

Screwed for Iron Pipe.

			£	s.	d.
⅜	inch	each	0	1	9
½	,, ...	,,	0	2	0
¾	,, ...	,,	0	2	9
1	,, ...	,,	0	6	0
1¼	,, ...	,,	0	11	0
1½	,, ...	,,	0	14	6
2	,, ...	,,	1	15	0

GAS REGULATORS.

With Mercurial Joint.

							£	s.	d.
For	8	Lights,	½	inch pipe	...	each	1	0	0
,,	15	,,	¾	,,	..	,,	1	14	0
,,	30	,,	1	,,	...	,,	2	5	0
,,	40	,,	1¼	,,	...	,,	3	6	0
,,	70	,,	1½	,,	. .	,,	4	10	0
,,	150	,,	2	,,	..	,,	7	12	0
,,	200	,,	3	,,	...	,,	11	15	0

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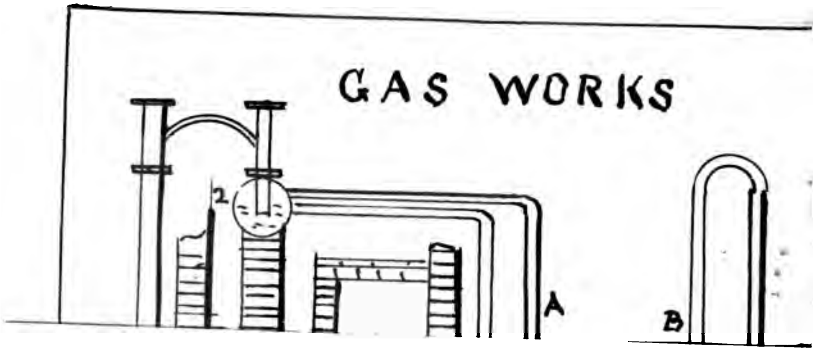
CONTENTS.

	Page.
Retorts	6
Hydraulic Main	7
Condenser	8
Tar Wells	8
Gas Meters	8, 16
Purifiers	
Gas Holder	
Gas Mains	
Regulators	12
Sun Light	
Main Cock	
Syphons	
Hydraulic Gasalier	
Harp Lights	
Gas Burners	12, [illegible]
Swing Pendant	2
Explosions Prevented	23
Photometer	23
Making Joints	22
Velocity of Gas in Pipes	15
Pipes, Sizes of, for Lights	14
Coals	5
Coke	5, 6
Gas, Quantity of, made from Coal	7
Davy Lamp	7
Gas, component parts of	8
Explosive Mixtures	9
Gas Pressure	9
Lights, Quantity for Buildings	16
Turning off the Gas	20
Gas Stove	22
Joints, Various	11, 22
Gas, Price of	23
Private Gas Apparatus, complete	24
Weight of Cast Iron Socket Pipes	25
Patent Welded Iron Gas Tube, Prices of	29
Patent Dry or Wet Gas Meters, Prices of	30
Brass Main Gas Cocks, Prices of	31
Gas Regulators, Prices of	3
Eldridge's Publications	31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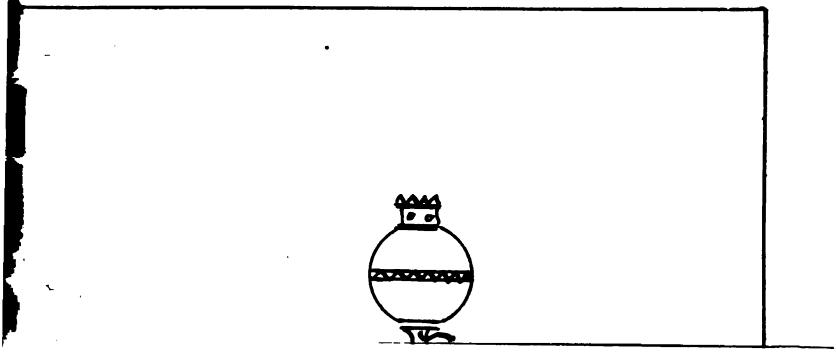

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